

Pavement Rehabilitation Through Ultra-Thin Whitetopping (UTW) Overlays

Introduction

The objective of this study has been to determine the feasibility of placing an ultra-thin whitetopping (UTW) overlay as a viable pavement rehabilitation method on low to medium volume asphaltic concrete (AC) pavements where rutting or shoving or both have become a problem, particularly at urban intersections. The procedure of milling and overlaying with asphaltic concrete is the least expensive and most commonly used practice in these areas. However, this usually serves as only a short-term fix. Other alternatives such as full depth asphalt or concrete pavement reconstruction are more expensive and cause more user delay. In lieu of these methods, an UTW overlay has been proposed as a more economic pavement rehabilitation alternative. UTW overlays are known to perform better and last significantly longer than a conventional AC overlay. In addition, UTW overlays are often placed using “fast track” paving techniques, and therefore, offer the long-term benefits of concrete pavement but allow for minimal delay during construction.

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A newly placed section of UTW overlay pavement at the intersection of Rte. 78 and Rte. 291 in Jackson County

An UTW overlay is known as a thin (2"-4") concrete overlay bonded to a milled, existing AC surface. Once milled, it's important that the AC surface be cleaned to further enhance bonding of the UTW overlay. After placement of the overlay, joints are sawn in both the transverse and longitudinal directions using a spacing of 1' per 1" of overlay thickness (e.g. for a 4" overlay, 4' x 4' panels). The short joint spacing and their narrow widths eliminate the need for joint sealant. It's strongly recommended that joints be sawn early to control cracking of the newly placed overlay. UTW overlays typically use conventional PCCP mixes reinforced with synthetic fibers or high early strength (HES) PCCP mixes with synthetic fibers, depending upon construction requirements. Good candidates for pavement rehabilitation with an UTW overlay should meet the following conditions:

- a minimum of 3" of existing sound asphalt after cold milling
- existing pavement must be over a sound base
- traffic volume should be low to medium

In April 1999, the first MoDOT UTW (4") was placed on U.S. Route 60 west of Neosho, Mo. in Newton County. In September 2000, MoDOT placed another UTW (3") at the intersection of Missouri Route 169 (Belt Highway) and Route YY in St. Joseph. In May and June 2003, MoDOT placed an UTW (4") at the intersection of Missouri Route 291 and Route 78 (23rd St) in Independence. The asphalt surface on all projects was coldmilled before having a thin layer (3" or 4") of PCC overlay placed as the driving surface. All the UTW overlays were placed according to MoDOT's UTW special provision using a PCCP mix containing synthetic fibers. Texture was then applied to the overlay using transverse tining. Application of curing compound then followed at 1.5 times the normal rate for standard PCCP pavement. After placement and initial curing, saws were used to cut panels (3' x 3' or 4' x 4') in the concrete surface with no joint sealant applied. Research, Development, and Technology (RDT) monitored the construction of all three projects. RDT is now performing visual distress surveys on a yearly basis to track in-service performance.

Project Descriptions

Route 60, Newton Co.

In April 1999, APAC of Missouri constructed the first UTW overlay placed on a state route in Missouri. The project was 0.80 mile in length with an intersection on the east end. The existing roadway was placed in 1960 on 10" of rolled stone base with 3" of type B and 1 1/4" type C asphalt mixes. In 1974, 1/2" of type C was used for leveling, followed with 1 1/4" type C asphaltic concrete. The full depth of the original asphalt of the two 12' lanes with variable width gravel shoulders was 7" thick. For the UTW overlay, 2"-4" of the existing asphalt pavement was coldmilled and then 4" of concrete pavement was placed.

The pre-construction visual survey indicated numerous moderate transverse cracks across both lanes of traffic. Several moderate longitudinal cracks were found in the wheel paths of both lanes. 75% of these cracks were removed during the milling operations. Following placement of the UTW overlay, only 4 transverse cracks that ran parallel to the sawed joints were observed within the first 48 hours. These cracks were found within the first 1,000' of the project and could be attributed to late sawing. Placing and furnishing costs on the Route 60 UTW project were \$6.00 per square yard and \$89.30 per cubic yard, respectively.

Route 169 and Route YY, Buchanan Co.

The existing intersection in St. Joseph consisted of four through lanes, each 12' wide, and a median or left turn lane 14' wide. The speed limit was 40 mph along Belt Highway and the amount of vehicles, especially trucks, that must stop and start again had provided the force necessary to cause a rutting and shoving problem. The original intersection included a PCC pavement, 40' wide, built in 1931. Additional 11' lanes were constructed in 1964 of 11" of plant mix bituminous base. In 1977, a 3" asphalt overlay was placed, and in 1989, a 1/2" leveling course, 1 3/4" of type B, and 1 1/4" of type C asphalt mixes were placed full width, overlaying the concrete and bituminous base lanes. For the UTW project, 3" of the existing asphalt pavement was coldmilled and 3" of UTW was placed.

This intersection project, performed by Realm Construction, was designed for construction to be completed over one weekend, with the east side of the intersection constructed first followed by the west side. "Fast Track" technology was applied, which places high early strength (HES) concrete mixtures that can be opened to traffic in a matter of hours instead of days. The maturity concept, a method of monitoring the early age and temperature of concrete to estimate in-place strength, was successfully used to facilitate early sawing and opening the pavement to traffic. There were no cracked panels observed within the first 48 hours after the pavement was placed. Placing and furnishing costs on the Route 169 and Route YY UTW project were \$19.00 per square yard and \$110.00 per cubic yard, respectively.

Route 291 and Route 78, Jackson Co.

The intersection at Rt. 291 and Rt. 78 had a long history of rutting and shoving. Maintenance repairs were being performed on a regular basis. The intersection has been subjected to a high volume of traffic, many of which have been trucks. The original intersection consisted of 17" of asphalt pavement with 2-12' thru lanes, 2-12' left turn lanes, and 1-12' right turn lane. For the UTW overlay, 4" of the asphalt surface was removed by coldmilling and replaced with 4" of concrete pavement.

The whitetopping project, performed by Musselman and Hall Construction, was scheduled for construction to be performed over two weekends, with the east side constructed first followed by the west side. “Fast Track” technology and HES concrete was used along with the maturity concept to facilitate early sawing and opening the pavement to traffic.

Pre-construction observations indicated that the existing asphalt pavement at the intersection exhibited signs of rutting, shoving, and moderate-heavy cracking, in both the longitudinal and transverse directions. Over 95% of the cracks were eliminated, along with the rutting and shoving, during the coldmill operation. Following placement, visual distress surveys were performed at 1 day with no cracked panels observed.

Table 1 provides additional information for all three UTW project locations.

Table 1 - Project Information

Route	County	Length	ADT	Trucks	Original Pavement Thickness	Milled	UTW Thickness	UTW sq. yd.
60	Newton	4200'	21,452	10%	7"	2-4"	4"	20,723
169	Buchanan	860'	12,920	8%	17"	3"	3"	6,600
291	Jackson	1600'	63,860	9%	19"	4"	4"	16,625

Project Performance Update

Route 60, Newton Co.

After the initial post-construction tests, annual falling weight deflectometer (FWD) and visual inspections were scheduled. The FWD has tested the UTW on Rt. 60 on a yearly basis since the completion of the project. The results indicate that the maximum deflections were in the 3-7 mil range, which is excellent. The UTW overlay continues to provide a composite modulus that is comparable for a structurally sound full depth asphalt pavement. Visual inspection results can be found in Table 2 and Figure 1. Most of the cracks found in the 4’ by 4’ panels during the yearly visual inspections were diagonal and approximately 2’ in length. There has been no evidence of spalling or debonding found along these cracks despite none of the cracks having been sealed. There have been no panels replaced and no maintenance has been performed on this project. Despite an increase in the percentage of cracked panels during the first year or so following placement of the UTW, it appears to have leveled off in the last couple of years. After 4 years of service, the UTW overlay on Rt. 60 is considered to be performing well.

Table 2 - Route 60

Time of Service	Total Panels	Panels Cracked	% Cracked
6 Months	6000	29	0.5
1 Year	6000	88	1.5
2 Years	6000	106	1.8
3 Years	6000	122	2
4 Years	6000	123	2

Route 169 and Route YY, Buchanan Co.

After the initial post-construction tests, visual inspections were performed at 1 month, 3 months, and yearly thereafter. Results can be found in Table 3 and Figure 1. It should be noted that 60 of the cracked panels found during the 1-year survey were reflective cracks from an asphalt seam in the original pavement. Nineteen of the cracked panels found were located in the right turn lane onto Rt. YY, an area where the UTW overlay did not meet the minimum recommended 3”. None of the cracks have been sealed by maintenance. Similar to the Rt. 60 UTW overlay, the percentage of cracked panels appears to have leveled off from an earlier increase. After 3 years of service, the UTW overlay at the intersection of Rt. 169 and Rt. YY appears to be performing well, with no maintenance being performed on the intersection. FWD testing will begin on the project starting this year.

Table 3 - Route 169

Time of Service	Total Panels	Panels Cracked	% Cracked
1 Month	4520	1	0.02
3 Months	4520	20	0.4
1 Year	4520	82	1.8
2 Years	4520	125	2.8
3 Years	4520	125	2.8

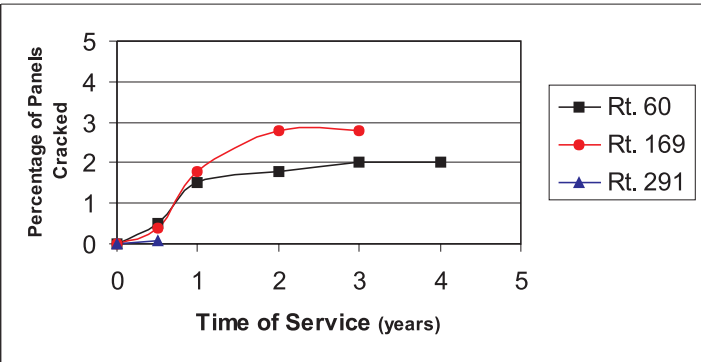
Route 291, Jackson Co.

After the initial post-construction tests, visual inspections were scheduled. Visual inspections were performed at 1 day and 6 months, and will continue yearly thereafter. Results can be found in Table 4 and Figure 1. This project was the most recent UTW overlay placed and only 6-month performance data has been included in this report. After 6 months of service, the UTW overlay placed at the intersection of Rt. 291 and Rt. 78 is performing comparable to the two earlier projects at similar ages. Of the cracks that have occurred, none have been sealed.

Table 4 - Route 291

Time of Service	Total Panels	Panels Cracked	% Cracked
6 Months	9352	8	0.08

Figure 1 - Percentage of Cracked Panels Over Time



Conclusions To Date

1. The three UTW projects are performing very well to date. All have eliminated the problems of rutting and shoving. UTW appears to be a viable alternative to using asphalt for an overlay, under the appropriate conditions (3" of existing sound asphalt pavement after milling operations, sound base, low to medium traffic volume, and low to medium truck traffic volume).
2. The UTW overlay must meet the minimum thickness to perform as designed.
3. FWD testing on Route 60, Newton Co. indicates the UTW overlay continues to provide a composite modulus that would be acceptable for a structurally sound full depth asphalt pavement with high structural integrity. No recent FWD testing has been performed on Route 169, Buchanan Co. and none is scheduled for Rt. 291.

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